Climate Change & Health – Student Instructions

Measure the Effects of a Greenhouse Gas

The production of **greenhouse gases** like **carbon dioxide** is the main driver of **climate change**. For this experiment, you will be testing to see how different gases affect the temperature inside a bottle that is exposed to bright light. You will be testing two atmospheres: one made of the normal air we breathe and another with a higher percentage of **carbon dioxide**.

Materials

- 2 large identical clear juice, soda, or water bottles (64 oz juice, 2 L soda, or 1 gal water work)
- 2 thermometers
- 4 teaspoons baking soda
- 1 cup vinegar
- Bright sunshine or a 100W or brighter incandescent light bulb and lamp (Fluorescent and LED light bulbs are great for the planet but not for this experiment.)
- Timer/stopwatch

First, decide how you are going to measure the temperature of your bottle. A digital thermometer designed for science or food use works best. The thermometer must have a wide enough range to measure air temperatures. Drop the thermometer in or poke a hole in the bottle or cap in which to stick your thermometer probe. If you only have one thermometer or bottle, you can test the two different setups back-to-back instead of simultaneously. Using this latter approach may impact the consistency of the experiment and the results.

Bottle 1: Normal atmosphere

Add 1 cup of water to the bottle and put on the bottle cap. This is a control to help keep the conditions similar in both bottles. Both bottles will have 1 cup of liquid in the bottom.

Bottle 2: High carbon dioxide

Fill the second bottle with **carbon dioxide** by reacting baking soda and vinegar.

$$\underset{\text{baking soda}}{NaHCO_3(s)} + \underset{\substack{\text{vinegar}\\(5\%\text{ acetic acid})}}{HC_2H_3O_2(aq)} \rightarrow NaC_2H_3O_2(aq) + H_2O(l) + \underset{\substack{\text{gas}\\\text{bubbles}}}{CO_2(g)}$$

CAUTION: **Carbon dioxide** is denser than air is, so it tends to sink and can be tricky to get out. If you put CO_2 in your bottle and want to do a normal air trial later using the same bottle, fill the bottle to the top with water and then dump it out to ensure that all the CO_2 is gone.

This next step can be messy, so consider completing this outside or in a sink should it overflow. Add 4 teaspoons (~12 g) of baking soda to your bottle. Pour in 1 cup of vinegar (~250 ml). This will react to produce vigorous bubbling. Swirl gently to mix. Once the bubbling has slowed down (after ~30 seconds), place the cap on the bottle. Too much pressure in the bottle may cause it to burst, so let the vigorous bubbling stop before capping.

Record Temperature Data

Insert your thermometers. Record your bottles' initial temperatures. Expose them to your chosen light source – either bright, direct sunlight or a 100W or brighter incandescent light bulb – and immediately start a timer. Record the temperature of both bottles every 20 seconds until they no longer change. The data table goes to 10 minutes, but once you've gotten three consistent temperatures in a row for both bottles, you can stop the experiment early. *Optional:* Consider repeating this experiment more than once. Multiple trials can add reliability to your data.

Make a Scientific Research Poster

Once you are done with your experiment, you need to present your findings to others. One way that scientists communicate information is through posters, usually at conferences or poster sessions designed for people to share their current research findings. These posters are large - usually around 4 ft x 5 ft. The poster template on the next page is a simplified version of what you might put on a poster after conducting original research.

If you prefer to make a digital poster, most are made as presentation slides using programs like Microsoft PowerPoint or Google Slides.

Title/Author: Include a descriptive title that draws the reader in. Also include your name and school or program along with any supervisors who helped you.

Introduction: Explain any background information that the reader needs to be able to understand your findings. You might need to do a little more research on the topic to be able to explain what **greenhouse gases** are and how they are produced.

Methods: Describe the procedure you are performing, including your experimental setup and how you are collecting your data. Make sure to explain what equipment you are using. Be as specific as possible so that someone reading your poster could perform this experiment on their own.

Results: What happened in your experiment? Include a summary of your data. This is section where you focus on WHAT patterns your data show, not WHY your data shows patterns. You collected numerical data, so make sure your results section includes your specific numbers rather than general phrases like "went up" or "decreased" when describing observed patterns. Your graph is also part of this section. Make sure it has a title, labels for both axes that include the units of measurement used, and a key to distinguish your two data sets.

Conclusions: What does your data mean? How do your results answer your research question? This is where you move from the WHAT happened into the WHY it happened. You can start to draw conclusions here about explanations for the patterns you see in the data.

Research a Health Effect of Climate Change

Now that you have explored the causes of **climate change**, let's shift to talking about its effects on public health. In the introduction, we briefly discussed nine different categories of public health issues that are connected to **climate change**. For this second activity, you will choose one of them to explore further.

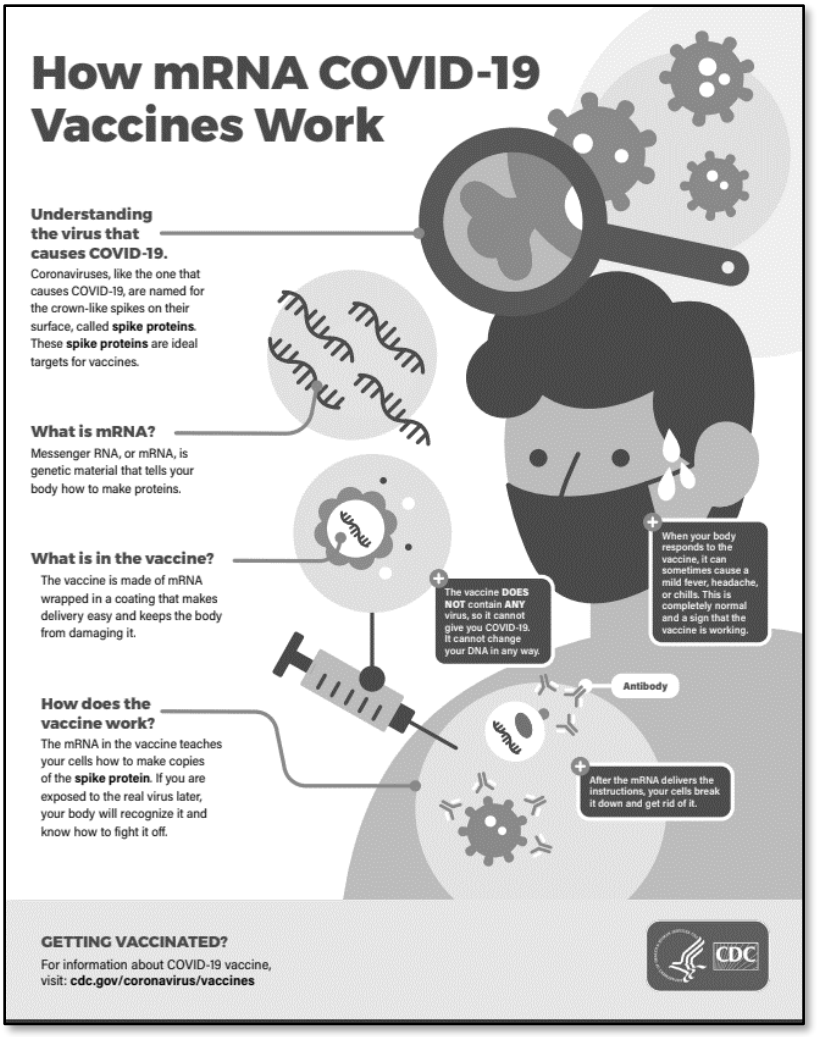
- Air pollution
- Allergens and pollen
- Diseases carried by **vectors**
- Food and **waterborne diseases**
- Food security
- Mental health and stress-related disorders
- Floods
- Temperature extremes
- Wildfires

Choose one of the nine topics listed and research using CDC's website (https://www.cdc.gov) or other credible sites such as those ending in .gov, ones connected to universities, or trustworthy nonprofits. You will likely find a lot of information, but you must remember to focus specifically on the effects of **climate change**, not just the general topic. As you are researching, consider the following questions:

- What are some ways that **climate change** affects your chosen health topic?
- What populations are most likely to face harms related to this topic due to **climate change**?
- How can we protect people, particularly those most vulnerable, from the health effects of **climate change** related to this topic?

Build an Infographic
Put your findings together by creating an infographic like the one pictured at right.

There are several great digital tools that can help you make excellent images. Try looking up "free infographic maker" online and explore a new tool!



Share Your Findings

For the full scientific research experience, conduct your very own poster session by explaining your poster and your infographic to family or friends. By explaining your findings to others, you deepen your own understanding and develop better communication skills.

Post your infographic on social media or share through email with others in your community. You can even ask your science teacher if you can display a copy in their classroom. You can share your research poster and infographic with the CDC Museum on Instagram using **@CDCmuseum**. The David J. Sencer CDC Museum uses award-winning exhibits and innovative programming to educate visitors about the value of public health and presents the rich heritage and vast accomplishments of CDC. Your experiments and infographic could be a valuable contribution!